भारतीय मानक
Indian Standard

IS 18272 : 2023

अवशिष्ट दबाव वाल्व और अवशिष्ट दबाव उपकरणों वाले सिलेंडर वाल्वों का टाइप परीक्षण — विशिष्टि

Residual Pressure Valves and Type Testing of Cylinder Valves Incorporating Residual Pressure Devices — Specification

ICS 23.020.30, 23.060.01

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October 2023 **Price Group 7**

Gas Cylinders Sectional Committee, MED 16

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards on recommendation of the Gas Cylinders Sectional Committee, had been approved by the Mechanical Engineering Divisional Council.

The cylinder valves that retain a small positive pressure in a gas cylinder is called residual pressure valve (RPV). The purpose of RPV is to retain a positive pressure in the cylinder greater than the pressure downstream of the valve outlet. It may also incorporate a non-return feature to prevent backflow into the cylinder from a higher pressure on the valve outlet.

A residual pressure cylinder in a gas cylinder and optionally prevent backflow of fluid by means of a non-return device, have been available for many years. Important benefits of RPVs include preventing moisture ingress and contamination, which reduce the potential for internal cylinder corrosion. Additional benefits include productivity improvements in the cylinder fill operation, avoiding internal cylinder contamination that could create hazardous situations and reducing cylinder maintenance.

While formulating this standard assistance has mainly been taken from ISO 15996 : 2017 'Gas cylinders — Residual pressure valves — Specification and type testing of cylinder valves incorporating residual pressure devices'.

While implementing this standard, the manufacturer and the inspection agency shall ensure compliance with statutory regulations. It is the responsibility of the owners and the users to ensure that the cylinders are periodically tested as per norms laid down in *Gas Cylinder Rules,* 2016 as amended from time to time and as enforced by statutory authorities under the rules.

The relevant SI units and corresponding conversion factors are given below for guidance:

$$1\ \text{kgf/cm}^2 = 98.066\,5\ \text{kPa (kilopascal)} = 10\ \text{m of Water column (WC)}$$
$$= 0.098\,066\,5\ \text{MPa (megapascal)}$$
$$= 0.980\,665\ \text{bar}$$
$$1\ \text{Pa} = 1\ \text{N/m}^2$$

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

RESIDUAL PRESSURE VALVES AND TYPE TESTING OF CYLINDER VALVES INCORPORATING RESIDUAL PRESSURE DEVICES — SPECIFICATION

1 SCOPE

1.1 This standard specifies design, type testing and marking requirements for cylinder valves incorporating residual pressure devices, hereinafter referred to as residual pressure valves (RPVs). The requirements mentioned in this standard are in addition to those given in IS 3224.

1.2 The specification does not apply to portable fire extinguishers, cryogenic equipment, low pressure refrigerant gases (cylinder test pressure less than 50 bar), dissolved gases, liquefied petroleum gases (LPG).

2 REFERENCES

The Indian Standard listed in below contain provisions which, through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below:

IS No.	*Title*
IS 3224 : 2021	Valve for compressed gas cylinders excluding liquefied petroleum gas (LPG) cylinders — Specification (*fourth revision*)
IS 7241 : 1981	Glossary of terms used in gas cylinder technology (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 7241 and the following shall apply.

3.1 Residual Pressure Valve (RPV) — Valve which incorporates a residual pressure device (*see* **3.2**).

3.2 Residual Pressure Device (RPD) — Device that is designed to prevent ingress of contaminants by maintaining a positive pressure within the cylinder relative to atmosphere by closing off its internal gas passages in the discharging direction.

3.3 Type 1 RPD — RPD (*see* **3.2**) that retains a positive pressure in the cylinder above the pressure downstream of the valve outlet and also incorporates a non-return feature to prevent backflow into the cylinder from a higher pressure on the valve outlet.

NOTE — Cylinders with RPVs with a type 1 RPD located between the filing port and cylinder cannot be filled or vacuumed unless the RPD is neutralized or a special fill connector is used to overcome the non-return feature.

3.4 Type 2 RPD — RPD (*see* **3.2**) that retains a positive pressure in the cylinder above atmospheric pressure but will not prevent backflow into the cylinder if the pressure on the valve outlet is high enough to overcome the RPD mechanism and the residual pressure in the cylinder.

NOTE — Cylinders with RPVs with a type 2 RPD can be filled with a conventional fill connector, but, if located between the filling port and cylinder, cannot be vacuumed or vented below the closing-off pressure unless the RPD is neutralized or a special fill connector is used.

3.5 Discharging Direction — Path taken by gas through the RPD (*see* **3.2**) when flowing out of the cylinder through the outlet connection.

3.6 Reverse Direction — Path taken by gas towards the RPD (*see* **3.2**) in the opposite direction to the discharging direction (*see* **3.5**).

3.7 Filling Direction — Path taken by gas through the RPV (*see* **3.1**) when filling the cylinder.

NOTE — Depending on the design of the RPV (**3.1**), filing direction and reverse direction (**3.6**) might be the same.

3.8 Opening Pressure — Differential pressure between upstream pressure and downstream pressure of the RPD (*see* **3.2**) at which the RPD starts to open to allow gas to flow in the discharging direction (*see* **3.5**).

NOTE — Due to the effects of manufacturing tolerances this is normally expressed as a pressure range.

3.9 Closing-Off Pressure — Cylinder pressure at which leak tight closure of the RPD (*see* **3.2**) is achieved during gas withdrawal through the outlet connection.

NOTE — Due to the effects of manufacturing tolerances and different discharge rates this is expressed as a pressure range.

3.10 RPV Working Pressure (P_w) — Settled pressure (filling pressure) of a compressed gas (for permanent gas) at a uniform reference temperature of 15 °C in a full gas cylinder for which the RPV (*see* **3.1**) is intended. For liquefiable gases, working pressure (P_w) shall be at least the maximum developed pressure in a cylinder at a temperature of 65 °C.

3.11 RPV Test Pressure (P_{vt}) — Minimum pressure applied to RPV (*see* **3.1**) during testing.

3.12 NTP — Normal temperature and pressure [20.0 °C (293.15 K), 1.013 bar absolute (0.1013 MPa absolute)].

3.13 RPV Filling Connector — Device fitted to the filling connection of RPVs (*see* **3.1**) fitted with type 1 RPDs (*see* **3.3**) during filling to overcome the non-return feature and for both type 1 and type 2 RPDs (*see* **3.4**) during venting and vacuuming.

NOTE — These connectors are design-specific and not standardized.

3.14 Standard Connector — Device that is manufactured to a standard which is fitted to the valve filling connection of a valve with or without RPD (*see* **3.2**) to allow users to withdraw gas from the cylinder and which can also be used to fill cylinders having RPVs (*see* **3.1**) fitted with type 2 RPDs (*see* **3.4**).

NOTE — These connectors are standardized.

3.15 RPD Neutralization Device — Device fitted to RPVs (*see* **3.1**) with type 2 RPD (*see* **3.4**) to neutralize the RPD (*see* **3.2**) if so designed and intended to be neutralized during filling and vacuuming.

4 RPV DESIGN CONSIDERATIONS AND REQUIREMENTS

4.1 Design Considerations

When designing RPVs the following aspects should be considered:

a) Mechanical stresses;
b) Chemical attack;
c) Noise caused by the RPD;
d) Spring material;
e) Valving into cylinders;
f) Avoiding mechanical interference caused by a gas withdrawal connector made in accordance with the relevant Standard;
g) Filling process;
h) Transport;
j) Integrity under high flow; and
k) End use of the cylinder.

4.2 Design Requirements

4.2.1 *General*

RPD shall operate within specification and be leak tight over a range of service temperatures, from at least – 20 °C to + 65 °C in indoor and outdoor environments.

4.2.2 *Valve Inlet Connection*

Valve inlet connection will be as per all the inlets specified in IS 3224.

4.2.3 *Valve Outlet Connection*

To accommodate the RPD, the internal dimensions of the RPV outlet connection are permitted to differ from IS 3224, provided safety and performance are not compromised and the modified design does not conflict with standard connectors.

4.3 Performance Requirements for RPD's

4.3.1 *Requirements for Type* 1 *and Type* 2 *RPD's*

4.3.1.1 *Opening pressure and closing-off pressure*

The opening pressure and closing-off pressure at room temperature shall meet manufacturer's specifications. To ensure reliable pre-fill checking of cylinders fitted with RPVs, the closing-off pressure at room temperature shall be no less than 1.5 bar. For specific applications, the closing-off pressure at room temperature may be reduced if agreed between the manufacturer and the purchaser.

In addition, the opening pressure and closing-off pressure at low and high temperatures (*see* Table 1) shall be measured and recorded to ensure that the RPD functions over the specified temperature range (*see* **4.2.1**).

NOTE — The verification of opening pressure and closing-off pressure is given in **5.6.1.**

4.3.1.2 *Leakage*

Leakage shall not exceed 6 cm^3/h corrected to NTP over the range of temperatures specified in Table 1.

NOTE — Leakage of 6 cm^3/h is approximately 4 bubbles of 3.5 mm diameter per minute.

4.3.1.3 *Endurance*

RPD shall meet the requirements for the opening and closing pressure given in **4.3.1.1** after endurance testing.

NOTE — The requirement is in addition to the endurance test specified in IS 3224, where the RPV is to be tested with the RPD neutralized using the manufacturer's recommended method or by using a RPV not fitted with the RPD.

The endurance test is given in **5.8.3**. After the endurance test and the subsequent tests/verifications have been performed a visual examination shall be carried out to ensure that no component is displaced (according to the manufacturer's drawing), non-functional (for example broken or damaged) or missing.

The visual examination is given in **5.8.5**.

4.3.2 *Additional Requirements for Type 1 RPDs*

4.3.2.1 *Resistance of the non-return function against pressure in the reverse direction for type 1 RPDs*

Type 1 RPDs shall be able to resist a hydraulic pressure of 1.5 × P_{vt} in the reverse direction without permanent visible deformation of the metallic components, damage of non-metallic materials or bursting of the RPD. The strength test of the non-return-function in the reverse direction for type 1 RPDs is given in **5.8.1**.

4.3.2.2 *Leak tightness in the reverse direction for type 1 RPDs*

Type 1 RPDs shall meet the leakage requirements given in **4.3.1.2** at 0.5 bar and P_{vt} applied in the reverse direction. The leak tightness test in the reverse direction for type 1 RPDs is given in **5.8.4**.

NOTE — This test is in addition to the tightness tests given in IS 3224.

5 RPV TYPE TESTING

5.1 General

5.1.1 To comply with this document, RPVs shall be type tested. A type test is valid for a given RPV design.

5.1.2 Some changes within the RPV design which could adversely affect RPD performance require tests to be repeated using the number of test samples quoted in Table 1 including:

a) Increase of RPV test pressure [repetition of all tests except verification of opening pressure and closing-off pressure, endurance test for type 2 RPDs];

b) Change of metallic RPD components material (repetition of any tests to be decided case by case depending on changes of chemical composition and mechanical properties);

c) Change of non-metallic RPD components material (repetition of all tests except for change in lubricant material where the strength test in the reverse direction for type 1 RPDs, the leak tightness test in the reverse direction for type 1 RPDs are not to be repeated);

d) Changes to the design of the RPD components, for example, piston diameter, dimension of O-ring(s), spring (repetition of tests to be decided case by case depending on the change); and

e) Change in piston length shall not require repetition of tests.

5.2 Documentation

The manufacturer shall make available, to the test laboratory:

a) A set of drawings consisting of the assembly drawing, parts list, material specifications including material standard for metallic materials and certificates (for the materials used for the test samples), and drawings with sufficient detail to permit satisfactory test sample verification (any change and/or material variant within the given valve design shall be clearly identified) including information about lubricants, their approximate amounts and where they are applied;

b) Marking information; and

c) A description of the RPV and method of operation including details of opening pressure and closing-off pressure of the RPD;

5.3 Test Samples

Complete RPVs shall be submitted as test samples. The number of test samples for testing a RPV design is given in Table 1. Additional test samples can be required for changes within the RPV design in accordance with the requirements of **5.1.2**. After testing, the test samples shall be rendered unserviceable or shall be clearly marked as test samples to avoid accidental entry into service.

5.4 Test Temperatures

The test temperatures are given in Table 1.

5.5 Test Pressures

5.5.1 *RPV Test Pressure*

P_{vt} is given by Formula (1):

$$P_{vt} = 1.2 \times p_w \quad \text{.................} \quad (1)$$

5.5.2 *Other Test Pressures*

The test pressures are given in Table 1.

5.6 Tests

5.6.1 *Verification of Opening Pressure and Closing-off Pressure*

In general, the verification should be carried out with air or nitrogen. Alternatively, helium, hydrogen or non-flammable mixtures of these gases may be used. Valves for helium, hydrogen or their mixtures, the test gas shall be helium, hydrogen or an inert mixture of these gases.

5.6.2 *Leak Tightness Test in the Reverse Direction for Type 1 RPDs*

In general, the leak tightness test should be carried out with air or nitrogen. Alternatively, helium, hydrogen, or non-flammable mixtures of these gases may be used. Valves for helium, hydrogen or their mixtures, the test gas shall be helium, hydrogen or an inert mixture of these gases.

5.6.3 *Endurance Test*

In general, the endurance test should be carried out with air or nitrogen.

5.7 Test Schedule

The tests shall be carried out in accordance with the schedule given in Table 1.

Table 1 Test Schedule for Type Testing for a Given RPV Design
(*Clauses* 4.3.1.1, 4.3.1.2, 5.1.2, 5.3, 5.4, 5.5.2, 5.8.2 *and* 5.8.3)

Sl No.	**Test**	**Test and Relevant Sub clause**	**Condition of Test Sample**	**Test Temperature** °C	**Test Pressure** bar	**Test Sample Number**	**Number of Tests per Sample**	**Total Number of Tests**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	1	Strength test of non-return function in reverse direction for type 1 RPDs, **5.8.1**	As received	Room temperature1)	1.5 × P_{vt}	1	1	1
ii)	2	Verification of opening pressure and closing-off pressure, **5.8.2**	As received	Room temperature1)	—	2 to 4	1	3
iii)	3	Endurance test, **5.8.3**	From test 2	Room temperature1)	*see* **5.8.3**	2 to 4	1	3
iv)	4	Verification of opening pressure and closing off pressure, **5.8.2**	From test 3	-20^{0}_{-5} Room temperature1) 65 ± 2.5	—	2 to 4	3	9
v)	5	Leak tightness test in the reverse direction for type 1 RPDs, **5.8.4**	From test 4	-20^{0}_{-5} Room temperature1) 65 ± 2.5	0.5 and P_{vt}	2 to 4	6	18
vi)	6	Strength test of the non-return function in the reverse direction for type 1 RPDs, **5.8.1**	From test 5	Room temperature1)	1.5 × P_{vt}	2	1	1
vii)	7	Visual examination, **5.8.5**	From test 5	Room temperature1)	—	3 to 4	1	2

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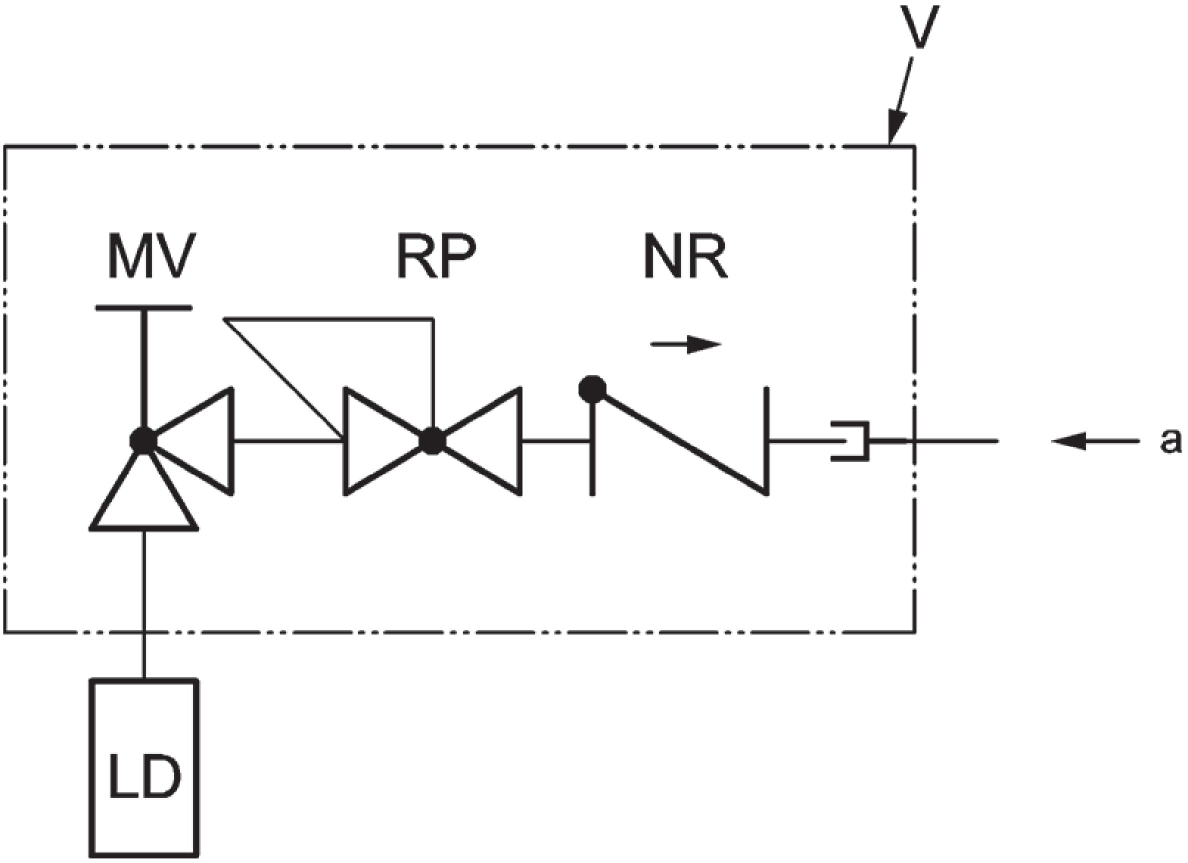
1) Typically between 15 °C and 30 °C.

5.8 RPD Performance Tests

5.8.1 *Strength Test of the Non-Return Function in the Reverse Direction for Type 1 RPDs*

The test has to be carried out with the valve operating mechanism (main shut-off) of the RPV open and with the RPV inlet connection open. The hydraulic pressure shall be applied via the RPV outlet connection and be raised continuously and gradually until at least 1.5 × P_{vt} is reached. The pressure shall be maintained for at least 2 min. After the test, the RPD and its components shall be subjected to a visual examination. An example of test equipment for the strength test is shown in Fig. 1.



Key

MV	valve operating mechanism (main shut-off)
RP	residual pressure feature (residual pressure device)
NR	non-return feature (non-return function)
LD	leak detector (optional for strength test)
V	RPV
a	Gas/liquid supply.

FIG. 1 TYPICAL EXAMPLE OF TEST EQUIPMENT FOR TYPE 1 PRDS FOR STRENGTH TEST OF THE NON-RETURN FUNCTION IN THE REVERSE DIRECTION AND TIGHTNESS TEST IN THE REVERSE DIRECTION

5.8.2 *Verification of Opening Pressure and Closing-off Pressure*

The opening pressure and closing-off pressure of all test samples shall be measured. The opening pressure and closing-off pressure at room temperature shall be verified against the manufacturer's specification. Test equipment shall not introduce any significant flow restrictions.

Before determining the opening pressure and closing-off pressure, the RPD shall be activated three times by pressurizing the RPV in the open condition via the valve inlet connection with twice the maximum opening pressure specified by the manufacturer.

Afterwards, the following procedure shall be applied at all required temperatures (according to Table 1) in the following sequence:

a) With the valve operating mechanism open, gradually pressurize the RPV from the valve inlet connection, using a pressurization rate of maximum 10 bar/min approx. The pressure shall be increased from 0 bar until gas is detected (for example visible bubbles) flowing from the RPV outlet connection. The opening pressure shall be recorded;

b) Close the valve operating mechanism;

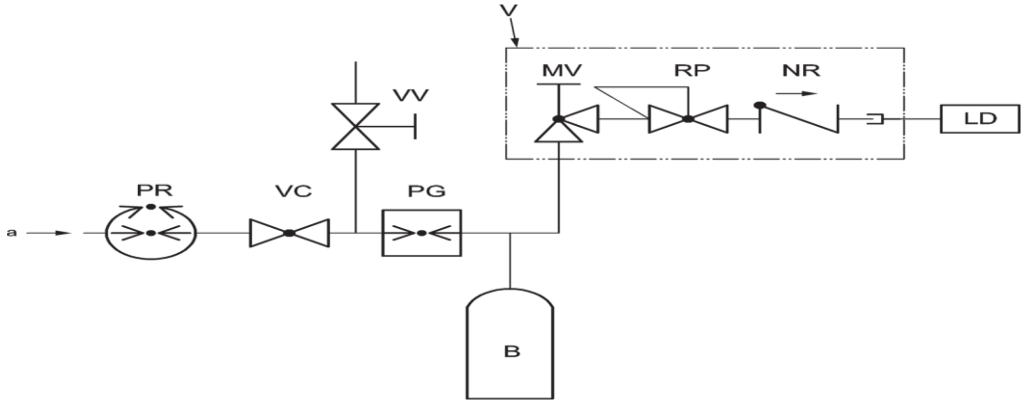
c) Further increase the pressure to fill the buffer upstream of the RPV (*see* Fig. 2) to a value of twice the maximum opening pressure as observed above;

d) Stop the pressure supply by closing the shut-off valve (*see* Fig. 2) to isolate the buffer;

e) Open the valve operating mechanism fully and let the pressure decrease through the RPV outlet until the RPD closes. The RPD is considered activated when the flow rate decreases suddenly. Measure the leakage rate. If the leakage rate meets **4.3.1.2**, the closing-off pressure has been reached and shall be recorded; and

f) If the leakage rate exceeds the value given in **4.3.1.2**, vent the gas upstream of the RPV to decrease the pressure in steps of 0.2 bar including a step at the pressure given in **4.3.1.1** and measure the leakage rate at each step. If the leakage rate meets **4.3.1.2**, the closing-off pressure has been reached and shall be recorded.

The opening pressure and closing-off pressure ranges are given by the lowest and highest pressures determined from the recorded data (before and after endurance testing) of all test samples at room temperature. An example of test equipment for the verification is shown in Fig. 2.



Key

PR	pressure regulator
VC	shut-off valve
VV	vent valve (between VC and PG)
PG	pressure gauge
B	buffer
V	RPV
MV	valve operating mechanism (main shut-off)
RP	residual pressure feature (residual pressure device)
NR	non-return feature (non-return function, for type 1 RPDs only)
LD	leak detector (for checking the closing-off pressure only)
a	gas supply

FIG. 2 TYPICAL EXAMPLE OF TEST EQUIPMENT FOR VERIFICATION OF OPENING PRESSURE AND CLOSING-OFF PRESSURE

5.8.3 *Endurance Test*

The RPD shall be cycled via the RPV inlet connection from the closed position to 2 times the maximum determined opening pressure of all test samples resulting from Test 2 of Table 1 or 10 bar, whichever is the greater.

Type 1 RPDs shall be tested for 100 000 cycles

Type 2 RPDs shall be tested for 2 000 cycles.

> NOTE — The number of cycles for type 2 RPDs is the same as the number of endurance cycles for the valve operating mechanism as specified in IS 3224 because the type 2 RPD does not open and close more frequently than the valve operating mechanism.

The cycle time should usually be set between 3 s and 10 s. Under exceptional circumstances, for example for high pressure RPDs, this time may be extended by agreement between the manufacturer and test laboratory. A device may be used for visual indication that the RPD opens and closes. An example of test equipment for the endurance test is shown in Fig. 3.

5.8.4 *Leak Tightness Test in the Reverse Direction for Type* 1 *RPDs*

The test has to be carried out with the valve operating mechanism (main shut-off) of the RPV open and with the RPV inlet connection open (which will allow to check for internal leakage). The pneumatic pressure shall be applied via the RPV outlet connection. The pneumatic pressure shall be raised continuously and gradually from 0.1 bar until 0.5 bar is reached. This pressure shall be maintained for at least 1 min before measuring the leakage rate. The pressure shall then further be raised continuously and gradually until P_{vt} is reached. This pressure shall be maintained for at least 1 min before measuring the leakage rate. An example of test equipment for the leak tightness test in the reverse direction for type 1 PRD is shown in Fig. 1.

5.8.5 *Visual Examination*

When the endurance test and the subsequent tests/verifications have been completed, components such as O-rings, gaskets, springs and diaphragms shall be subjected to a visual examination. Note shall be made of any components appearing to be excessively worn even though the RPD met the requirements. During the visual examination verification that the RPD and its components correspond to the submitted set of drawings shall be carried out and recorded.

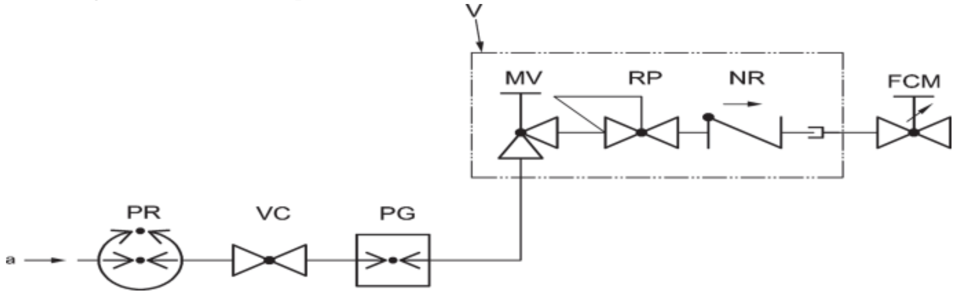
6 MARKING

6.1 RPVs complying with this specification shall be marked with the following in addition to the requirements of IS 3224:

a) All RPVs incorporating a type 1 RPD shall be marked with “T1”. RPVs for specific applications not having a closing-off pressure of minimum 1.5 bar (*see* **4.3.1.1**) shall be marked with “T1A”; and

b) All RPVs incorporating a type 2 RPD shall be marked with “T2”. RPVs for specific applications not having a closing-off pressure of minimum 1.5 bar (*see* **4.3.1.1**) shall be marked with “T2A”.

6.2 The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.



Key

PR	pressure regulator
VC	shut-off valve
PG	pressure gauge
V	RPV
MV	valve operating mechanism (main shut-off)
RP	residual pressure feature (residual pressure device)
NR	non-return feature (non-return function, for type 1 RPD only)
FCM	flow measuring device (optional)
a	gas supply

FIG 3 EXAMPLE OF TEST EQUIPMENT FOR THE ENDURANCE TEST

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Gas Cylinder Sectional Committee, MED 16

Organization	*Representative(s)*
Petroleum and Explosive Safety Organization, Nagpur	Shri P. Kumar **(*Chairperson*)** Shri K. S. Rao (*Alternate*)
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Member Secretary
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(Mechanical Engineering), BIS

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